

Scalar wormholes with nonminimal derivative coupling

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Abstract

We consider static spherically symmetric wormhole configurations in a gravitational theory of a scalar field with a potential $V(\phi)$ and nonminimal derivative coupling to the curvature described by the term $(\epsilon g_{\mu\nu} + \kappa G_{\mu\nu})\phi_{;\mu}\phi_{;\nu}$ in the action. We show that the flare-out conditions providing the geometry of a wormhole throat could be fulfilled both if $\epsilon = -1$ (phantom scalar) and $\epsilon = +1$ (ordinary scalar). Supposing additionally a traversability, we construct numerical solutions describing traversable wormholes in the model with arbitrary κ , $\epsilon = -1$ and $V(\phi) = 0$ (no potential). The traversability assumes that the wormhole possesses two asymptotically flat regions with corresponding Schwarzschild masses. We find that asymptotical masses of a wormhole with nonminimal derivative coupling could be positive and/or negative depending on κ . In particular, both masses are positive only provided $\kappa < \kappa_1 \leq 0$; otherwise, one or both wormhole masses are negative. In conclusion, we give qualitative arguments that a wormhole configuration with positive masses could be stable. © 2012 IOP Publishing Ltd.

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